# Present Status of Oriental and Mediterranean Fruit Flies and Their Parasites at Three Locations on Oahu, Hawaii

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## ABSTRACT

To establish present status of the oriental fruit fly (OFF), *Dacus dorsalis* Hendel, and the Mediterranean fruit fly (MED), *Ceratitis capitata* (Wiedemann), and their parasitoids on Oahu, Hawaii, a study was carried out from August to December 1987, by collecting guava fruit and trapping adult males with lures at three locations; Mt. Tantalus, Lyon Arboretum and Waimanalo.

Mean weights of individual guava fruit collected from Mt. Tantalus, Lyon Arboretum, and Waimanalo were found to be 74.0 g, 78.2 g, 9.7 g respectively. Only OFF emerged from 180 fruit which were held in the laboratory, although adult males of MED were trapped at Waimanalo. Populations of OFF were most abundant at the highest elevation, Mt. Tantalus, where the mean number of flies trapped with a methyl eugenol lure in 15 minutes was 55.5. Numbers trapped at the middle elevation, Lyon Arboretum, and lower elevation, Waimanalo, were 29.7, 29.0 respectively. The number of puparia per kg fruit sampled was highest (72.0) at the lowest elevation, Waimanalo. The numbers of puparia per kg fruit from the middle and highest elevations were 60.5, 48.4 respectively.

Mean parasitism by the opiine wasp *Biosteres arisanus* (Sonan) was 48.8%, 37.7%, 29.6% respectively for Mt. Tantalus, Lyon Arboretum and Waimanalo.

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Fruit flies of the family Tephritidae are well-known pests. Their attack on fruit reduces both yield and quality. Four species of this family have been accidentally introduced into Hawaii (Gilmore 1986). The melon fly (MEL), *Dacus cucurbitae* Coquillet, first found in Hawaii during 1895, has caused serious losses to melons, vegetables, papayas, passion fruit and beans. The second introduction in 1910 was the Mediterranean fruit fly (MED), *Ceratitis capitata* (Wiedemann). Its host range includes more than 250 fruits, vegetables and nuts. The oriental fruit fly (OFF), *Dacus dorsalis* Hendel, was the third introduction, in 1946. This species attacks more than 236 kinds of fruit and vegetables. The most recent introduction, in 1983, was the solanaceous fruit fly (SFF), *Dacus latifrons* (Hendel), which infests eggplant, chili pepper and tomatoes (Vargas and Nishida 1985). Presence of these species in Hawaii has an adverse effect on fruit production and poses a constant threat of introduction into the U.S. mainland.

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In the past, many efforts have been made to suppress populations of the MED, OFF and MEL fly through import of exotic parasitoids from different parts of the world (Bess 1953; Clausen et al. 1965; Haramoto and Bess 1970), and the biological control agents have achieved much success.

Levels of parasitization fluctuate with season of the year, type of host and ripeness of fruit. Bess (1953) observed 50 percent parasitization in MED and OFF by a braconid, *Opius oophilus* (Fullaway) [= *Biosteres arisanus* (Sonan)]. According to Kaya (1966), the level of parasitism by this parasitoid on OFF increased with increased superparasitism. Parasitism of both MED and OFF due to *O. oophilus* was determined by various authors to be from 65 to 70 percent (Haramoto and Bess 1970), 80 percent (Wong et al. 1984) and 74 percent (Wong and Ramadan 1987).

Although both Mediterranean fruit fly and oriental fruit fly infest the same hosts, the former was found to be more abundant in upland areas and latter in lowland areas (Bess 1953). Wong et al. (1983) found that in peach fruit larger numbers of MED were recorded than OFF at higher elevations. Eclosion data of these authors further revealed that both of the species could develop successfully together in peach fruit.

Howlett (1912) reported that the OFF and the peach fruit fly, *Dacus zonatus* (Saunders), are attracted to methyl eugenol. This lure is known to be extremely attractive to the OFF (Steiner 1952), and male populations of this species were eradicated up to 99 percent with the use of methyl eugenol combined with three percent naled (Steiner et al. 1965). Populations of adult males of MED fly (Vargas et al. 1983; Wong et al. 1985; Harris and Lee 1986) and OFF (Wong et al. 1985) were monitored with traps baited with appropriate lures and toxicant.

The present study was undertaken to determine the level of parasitism and occurrence of MED and OFF at three locations on Oahu. The results of field and laboratory investigations are presented below.

## MATERIALS AND METHODS

Sampling of host guava fruit was carried out on Oahu where it is seasonally abundant. Three sampling sites were established, ranging from 21 meters to 474 meters elevations. The Mt. Tantalus site is located at 474 meters on the leeward side of the Koolau Range near Honolulu where guava trees grow wild on hillsides. Lyon Arboretum is on the plateau at the head of Manoa Valley at an elevation of 156 meters. In this area guava trees are scattered around Paradise Park, which is surrounded by thick forest. Waimanalo is at 21 meters elevation on windward side of Oahu at the foot of the Koolau Range, where cultivated varieties of guavas are grown at the Waimanalo Experiment Station, University of Hawaii. Rainfall and temperature data for each sampling area during the period of study (August 25 to November 10, 1987) were obtained from the respective offices (Tables 1 and 3).

Sampling was initiated on August 25, 1987 and continued at weekly intervals throughout the study period. On each sampling day, 10 to 12 mature

and firm ripe guava fruits were picked from trees in each sampling area and promptly taken in polyethylene bags to the laboratory. In the laboratory, five fruits which had fruit fly ovipositional punctures were selected, weighed, transferred singly to paper cups containing sand and covered with paper lids or nylon organdy cloth. Sand in holding cups was sifted at weekly intervals, and pupae were removed and held in glass vials (2 cm diameter and 9 cm high), plugged with cotton wool, for emergence of fruit flies and parasitoids. In the laboratory, paper cups and glass vials were held separately for pupation and eclosion at room temperature and humidity (Table 2). On emergence, the numbers of fruit flies and parasitoids were recorded. The parasitoids were identified to species with the key of Wharton and Gilstrap (1983).

For trapping adult males of MED and OFF, Moroccan vertical traps (Hafraoui et al. 1980) made from plastic food containers (10 cm diameter, 12 cm high with four holes 2.5 cm diameter on sides) and baited with appropriate lures, were set up on non-host trees 20 meters apart in each sampling area. Medfly traps contained a wick treated with 2 ml tri-med lure on a 2.5 cm cotton dental roll having 3% dichlorvos as a toxicant (Harris et al. 1986), and were allowed to remain exposed throughout the period of study. In addition, each trap contained 2 cm piece of Sergeant's flea and tick collar impregnated with 15% naled. This was to kill ants that might enter the trap and feed on the flies. Oriental fruit fly traps, baited with 5 ml of a mixture of methyl eugenol (98%) and naled (2%) in a cotton wick 4 cm long, and 2 cm diameter (Wong et al 1986), were set up at each site for 15 minutes on each sampling day. The numbers of fruit flies trapped during each trapping period were recorded for each location. The lures were replenished twice during the study period.

## RESULTS

**Trap Data.** Trap catches of the two tephritid species are presented in Table 3. OFF was detected in all the sampling areas. Although, tri-med lure traps remained in the field throughout the experimental period in each sampling area, MED were trapped only at Waimanalo (Table 3) where sterile flies of this species had been released for a scientific study. This indicated that the lure was effective.

At Mt. Tantalus, Lyon Arboretum and Waimanalo, the mean numbers of OFF caught in traps were 55.5, 29.7, 29.0 per 15 minutes, respectively. The density of this species was much higher at Mt. Tantalus, which had a mean temperature of 25.2C and rainfall of 480.8 mm, than at Lyon Arboretum and Waimanalo, where mean temperature and rainfall were 26.0C and 29.4C, and 691.6 mm and 153.7 mm, respectively (Tables 1 and 3). At Lyon Arboretum and Waimanalo, the numbers of flies trapped were almost the same. Guava trees are abundant around Mt. Tantalus, which may explain why larger numbers of fruit flies were caught there, compared with Lyon Arboretum, and Waimanalo, where there are fewer guava trees.

**Host Fruit Data.** The weight (Table 4) of individual guava fruit collected from Waimanalo was the greatest, followed by Lyon Arboretum and Mt. Tantalus. The largest number of pupae per kg fruit (72.0) was recovered from collections from Waimanalo. The numbers of pupae per kg fruit from collections from Lyon Arboretum and Mt. Tantalus were 60.5 and 48.4, respectively.

No MED emerged from the puparia from fruit collections from any of the three sampling sites. Only OFF and its opiine parasitoid, *Biosteres arisanus* (Sonan), were recovered. Total numbers of OFF and parasitoids which emerged from fruit collections from Mt. Tantalus, Lyon Arboretum and Waimanalo were 20, 29, 110, and 105, 107, 127 respectively. Eclosion percentage was highest (58.1) in the collections from Mt. Tantalus, and the lowest (47.9) from Lyon Arboretum. Parasitism by *B. arisanus* was higher (48.8%) at the highest elevation, Mt. Tantalus, followed by Lyon Arboretum (37.7%) and Waimanalo (29.6%).

## DISCUSSION

These results clearly show that the most dominant species of fruit fly in the sampling areas was the oriental fruit fly. Mediterranean fruit fly was not reared from guava fruit during this study. The results presented here differ from those of previous authors (Bess 1953; Haramoto and Bess 1970; Vargas et al. 1983 and 1985) as they recovered both species from guava fruit, while we reared only the oriental fruit fly.

Use of the Morocco vertical traps was effective for catching both species of fruit flies.

Temperature, rainfall and host plants (Wong et al. 1983) affected population levels of fruit flies. In this study the highest numbers of male adults of the OFF were caught with traps at Mt. Tantalus, the highest elevation site, which also had abundant wild guava trees in the immediate vicinity. But the recovery of puparia per kg fruit was greatest from Waimanalo, which is the lowest elevation with the lowest rainfall. The number of puparia recovered was lowest at Mt. Tantalus. Our data are not in agreement with Vargas et al. (1983) who captured low numbers of fruit flies from upland forest areas on Kauai. However, Vargas referred to captures of OFF above 800 m in native forests, above most of the guava. Nevertheless, our results are in line with the findings of Wong et al. (1983) and Wong et al. (1985) who caught larger numbers of mixed populations of both species from higher elevations.

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**TABLE 1.** Temperature and rainfall data for the three sampling sites from August 25 to November 10, 1987.

| Location | Elevation (m) | Temperature Max °C (Range) | Temperature Min °C (Range) | Rainfall (mm) |
|---|---|---|---|---|
| Mt. Tantalus | 474 | — | — | 480.8 |
| Lyon Arboretum | 156 | 26.1-31.7 | 18.9-26.1 | 641.6 |
| Waimanalo | 21 | 24.5-33.3 | 18.9-23.9 | 153.7 |

**TABLE 2.** Monthly mean temperatures and relative humidity maintained in the laboratory, September to November, 1987.

| Month | Mean Temperature (°C) | Mean Relative Humidity (%) |
|---|---|---|
| September | 23.9 ± 0.4 | 75.8 ± 2.5 |
| October | 23.6 ± 0.8 | 73.9 ± 2.8 |
| November | 23.0 ± 0.3 | 72.0 ± 2.0 |

**TABLE 3.** Numbers of adult males of the oriental fruit fly (OFF), *D. dorsalis* and the Mediterranean fruit fly (MED), *C. capitata* caught in plastic traps baited with lures[1] at three elevations on Oahu, Hawaii, September to November, 1987.

| Date of Collection | | Mt. Tantalus (474 m) | | | Lyon Arboretum (156 m) | | | Waimanalo (21 m) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | MED | OFF | Temperature (°C) | MED | OFF | Temperature (°C) | MED | OFF | Temperature (°C) |
| September | 1 | 0 | 26 | 24.5 | 0 | 6 | 25.0 | 0 | 12 | 30.0 |
| | 8 | 0 | 42 | 24.5 | 0 | 22 | 25.6 | 0 | 10 | 32.2 |
| | 15 | 0 | 45 | 24.5 | 0 | 12 | 25.6 | 0 | 11 | 31.1 |
| | 23 | 0 | 72 | 28.9 | 0 | 37 | 27.8 | 0 | 4 | 30.0 |
| | 29 | 0 | 33 | 26.7 | 0 | 34 | 28.9 | 0 | 17 | 29.5 |
| October | 6 | 0 | 48 | 24.5 | 0 | 35 | 26.7 | 0 | 44 | 29.5 |
| | 13 | 0 | 58 | 24.5 | 0 | 27 | 25.6 | 10 | 78 | 26.7 |
| | 20 | 0 | 32 | 22.8 | 0 | 23 | 24.5 | 15 | 38 | 28.9 |
| | 27 | 0 | 87 | 26.7 | 0 | 30 | 26.7 | 4 | 16 | 28.9 |
| November | 13 | 0 | 101 | 23.3 | 0 | 43 | 24.5 | 0 | 65 | 27.8 |
| | 10 | 0 | 67 | 26.7 | 0 | 58 | 25.6 | 2 | 24 | 28.9 |
| Mean | | 0 | 55.5 | 25.2 | 0 | 29.7 | 26.0 | 2.8 | 29.0 | 29.4 |

[1]Medfly lure: Tri-med lure 2 ml + naled in field during the whole experimental period.
Oriental fruit fly lure: methyl eugenol 5 ml + naled, exposed for 15 minutes on each date.

**TABLE 4.** Percent parasitization of the oriental fruit fly (OFF), *Dacus dorsalis* infested guava sampled at three different elevations on Oahu, Hawaii, August to November, 1987.

| Location | Date of collection | | Weight of fruit (gm)[1] | Number of puparia | Number of OFF emerged | Percent eclosion | Number of parasitoids[2] | Percent parasitism |
|---|---|---|---|---|---|---|---|---|
| Mt. Tantalus (474 m) | August | 25 | 340.8 | 55 | 7 | 36.4 | 13 | 23.6 |
| | September | 1 | 336.2 | 5 | 0 | 40.0 | 2 | 40.0 |
| | | 8 | 450.4 | 9 | 0 | 88.9 | 8 | 88.9 |
| | | 15 | 339.2 | 68 | 3 | 72.1 | 46 | 76.7 |
| | | 23 | 383.7 | 17 | 2 | 64.7 | 9 | 52.9 |
| | | 29 | 365.6 | 16 | 3 | 62.5 | 7 | 43.8 |
| | October | 6 | 452.6 | 2 | 0 | 50.0 | 1 | 50.0 |
| | | 13 | 340.1 | 15 | 0 | 86.7 | 13 | 86.7 |
| | | 20 | 361.2 | 19 | 2 | 64.4 | 11 | 57.9 |
| | | 27 | 378.2 | 2 | 0 | 100.0 | 2 | 100.0 |
| | November | 3 | 412.1 | 5 | 3 | 100.0 | 2 | 40.0 |
| | | 10 | 279.6 | 2 | 0 | 50.0 | 1 | 50.0 |
| Lyon Arboretum (156 m) | August | 25 | 487.8 | 64 | 8 | 42.2 | 19 | 29.7 |
| | September | 1 | 361.2 | 82 | 6 | 28.0 | 17 | 20.7 |
| | | 8 | 353.5 | 38 | 2 | 55.3 | 19 | 50.0 |
| | | 15 | 360.4 | 37 | 1 | 81.1 | 29 | 78.4 |
| | | 23 | 521.7 | 3 | 0 | 66.7 | 2 | 66.7 |
| | | 29 | 338.5 | 23 | 2 | 47.8 | 9 | 39.1 |
| | October | 6 | 381.4 | 13 | 2 | 61.5 | 6 | 46.2 |
| | | 13 | 407.8 | 6 | 2 | 50.0 | 1 | 50.0 |
| | | 20 | 392.3 | 3 | 1 | 100.0 | 2 | 66.7 |
| | | 27 | 431.3 | 3 | 1 | 66.7 | 1 | 33.3 |
| | November | 3 | 321.8 | 5 | 3 | 60.0 | 0 | 0 |
| | | 10 | 337.0 | 7 | 1 | 42.9 | 2 | 28.6 |

[1]A sample of five tree fruit with ovipositional punctures.
[2]*Boisteres arisanus* (Sonan) ( = *Opius oophilus*), a braconid egg-larval parasitoid.

**TABLE 4.** Percent parasitization of the oriental fruit fly (OFF), *Dacus dorsalis* infested guava sampled at three different elevations on Oahu, Hawaii, August to November, 1987. *(Continued)*

| Location | Date of collection | | Weight of fruit (gm)[1] | Number of puparia | Number of OFF emerged | Percent eclosion | Number of parasitoids[2] | Percent parasitism |
|---|---|---|---|---|---|---|---|---|
| Waimanalo (21 m) | August | 25 | 683.7 | 80 | 15 | 33.7 | 12 | 15.0 |
| | September | 1 | 587.0 | 61 | 7 | 55.7 | 26 | 42.6 |
| | | 8 | 390.3 | 87 | 46 | 60.9 | 6 | 6.9 |
| | | 15 | 429.9 | 56 | 18 | 83.9 | 29 | 51.8 |
| | | 23 | 656.6 | 13 | 1 | 69.2 | 8 | 61.5 |
| | | 29 | 681.7 | 11 | 1 | 18.2 | 1 | 9.1 |
| | October | 6 | 531.6 | 25 | 7 | 64.0 | 10 | 40.0 |
| | | 13 | 518.5 | 7 | 0 | 71.4 | 5 | 71.4 |
| | | 20 | 382.7 | 27 | 5 | 63.0 | 12 | 44.5 |
| | | 27 | 428.5 | 9 | 2 | 88.9 | 6 | 66.7 |
| | November | 3 | 268.2 | 27 | 5 | 44.4 | 7 | 25.9 |
| | | 10 | 379.1 | 25 | 2 | 32.0 | 6 | 24.0 |

[1]A sample of five tree fruit with ovipositional punctures.
[2]*Boisteres arisanus* (Sonan) ( = *Opius oophilus*), a braconid egg-larval parasitoid.